UNITED STATES ATOMIC ENERGY COMMISSION

AECD-2822

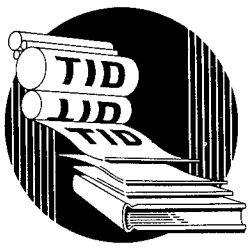
PREPARATION OF TRANSPLUTONIUM ISOTOPES BY NEUTRON IRRADIATION

By
A. Ghiorso et al.

February 28, 1950

University of California,
Radiation Laboratory

6



Technical Information Division, ORE, Oak Ridge, Tennessee

PREPARATION OF TRANSPLUTONIUM ISOTOPES BY NEUTRON IRRADIATION*

By A. Ghiorso, R. A. James,† L. O. Morgan,‡ and G. T. Seaborg

The first production of isotopes of the transplutonium elements americium (atomic number 95) and curium (atomic number 96) was reported[1] by the present authors in a preliminary way in 1945 and more recently[2] in a more complete fashion. In these communications it was pointed out that a number of americium isotopes may be formed in cyclotron bombardments with various charged particles and in particular that the approximately 500-yr Am^{241} may be produced with approximately 40-Mev helium ions according to the reactions $U^{238}(\alpha,n)Pu^{241} \xrightarrow{\beta^- (10\text{-yr})} Am^{241}$. It was also reported that a number of curium isotopes may be formed by cyclotron bombardments with charged particles and in particular that the 150-day Cm^{242} may be prepared by the 40-Mev helium ion bombardment of Pu^{239} according to the reaction $Pu^{239}(\alpha,n)Cm^{242}$. It was also pointed out that Cm^{242} may be formed by neutron irradiation of Am^{241} according to the reactions $Am^{241}(n,\gamma)Am^{242} \xrightarrow{\beta^-} Cm^{242}$ where Am^{242} exists in two isomeric states with half-lives for beta-emission given as 17 hr and some 10^2 to 10^3 years.

The purpose of the present note is to point out that the isotope Am^{241} may also be formed by neutron irradiation, according to the following reactions $Pu^{239}(n,\gamma)Pu^{240}(n,\gamma)Pu^{241} \xrightarrow{\beta^- (10\text{-yr})} Am^{241}$. This method of production was first observed by the authors of this note late in 1944 and the use of the chain reacting piles as a source of neutrons makes it the best for the production of weighable amounts of Am^{241}. (The first evidence for the reaction $Pu^{239}(n,\gamma)Pu^{240}$ was that of Chamberlain, Farwell, and Segré.[3]) In fact, the intense irradiation of large quantities of plutonium leads to the production of milligram amounts of Am^{241}. The cross section of Am^{241} for the n,γ reaction is such that it is possible with long irradiations at high neutron fluxes to transmute a substantial fraction of it to Cm^{242}.

The fact that the elements americium and curium, as represented by their isotopes Am^{241} and Cm^{242}, may be prepared in substantial quantity in this manner by pile neutron irradiations makes it possible to investigate rather completely the chemical properties of these elements using weighable amounts. The existence of these reactions makes it quite likely that even higher mass isotopes may be prepared by n,γ reactions and in fact further work at this laboratory, to be published soon, indicates that this is indeed the case.

This work was performed at the wartime Metallurgical Laboratory, University of Chicago, Chicago, Illinois (now the Argonne National Laboratory) under the auspices of the Manhattan District, and at the Radiation Laboratory and Department of Chemistry, University of California, Berkeley, under the auspices of the Manhattan District and the United States Atomic Energy Commission.

REFERENCES

1. G. T. Seaborg, Chem. and Eng. News, 23: 2190 (1945).
2. G. T. Seaborg, R. A. James, and L. O. Morgan, National Nuclear Energy Series, Div. IV, Vol. 14B, Part II, The Transuranium Elements: Research Papers, Paper No. 22.1, "The New Element Americium (Atomic Number 95)," and G. T. Seaborg, R. A. James, and A. Ghiorso, ibid., Paper No. 22.2, "The New Element Curium (Atomic Number 96)," McGraw-Hill Book Company, Inc., New York, 1949.
3. O. Chamberlain, G. W. Farwell, and E. Segré, private communication (Sept. 1944).

---

*Work performed under Contract No. W-7405-eng-48.

†Now at the Department of Chemistry, University of California at Los Angeles.

‡Now at the Department of Chemistry, University of Texas, Austin, Texas.

AEC, Oak Ridge, Tenn., 7-15-50--900-A21060